PART I.

GENERAL DISCUSSION ON THE SUBJECT.

1. History of former enquiries carried out with a view of ascertaining the possibility of manufacturing paper-pulp from Bamboos.

Origin of the enquiry.—The idea of manufacturing paper-pulp from bamboos is not a new one. During the early seventies of the last century, Esparto grass was chiefly in use for the manufacture of paper, and just about that time the demand for cheap paper began to exceed the available supply of this grass. Paper-pulp manufacturers were therefore on the look-out for suitable substitutes and amongst others which came under their notice were conifer woods and bamboos. The conifer woods won the day, being obtainable nearer the European market, so that to-day at least three-fourths of the world's supply of paper is made from spruce and pine woods. The bamboo, however, during that period, received a fair amount of attention. The Government of India instituted an enquiry in 1873, the report on which deals with possible fibre-yielding plants, their strength and general qualities.

Enquiry by Hem Chandra Kerr in 1874.—The next publication on the subject of Indian fibres is by Babu Hem Chandra Kerr, entitled "The Cultivation of Jute in Bengal, and on Indian Fibres available for the Manufacture of Paper."

T. Routledge's enquiry of 1875.—We next find an Englishman, namely, Mr. Thomas Routledge of Sunderland, taking an interest in bamboos, at just about the time of the crisis when the supply of Esparto grass was becoming insufficient to meet the demand. It may be said that it was to this gentleman's initiative that bamboos began to be seriously thought of as a possible raw material from which to manufacture paper-pulp. He published two notes on the subject, one in 1875, entitled "Bamboo considered as a Paper-making Material" and another entitled "Bamboo and its Treatment" which appeared in 1879.

Liotard's Report of 1883.—In 1883, Mr. Liotard published a note on "Paper-making Industry in India" which deals directly with the consumption of paper in India and the United Kingdom and discusses Railway Rates, which do not, however, apply at the present time.

E. E. Fernandez's Report of 1890.—About 1890, there appeared an article in the "Indian Forester" by Mr. E. E. Fernandez, late Conservator of Forests, entitled "Wood Cellulose and Wood-pulp," in which he describes the various methods of preparing wood-pulp, especially those in vogue in French mills. The article is most instructive as explaining the methods of preparing pulp by the mechanical and soda processes.

Articles in the "Indian Forester."—Many articles have appeared from time to time in the "Indian Forester," notably two by Mr. Clutterbuck in 1899 and 1900, in which estimates are given as to the working of a mill using Himalayan conifers.

Report by S. Chas. Philipps of 1905.—In 1905, Mr. S. Chas. Philipps, M.S.C.I., read a most able article before the Society of Arts, London, on the subject of the manufacture of mechanical and chemical paper-pulp, in which he describes the various processes and their origin.

R. S. Sindall's Report of 1906.—It is not, however, until we come to Mr. Sindall's report on the "Manufacture of Paper and Paper-Pulp in Burma" that we find really definite information regarding the possibility of preparing pulp from bamboos and Indian woods. His report is divided into two parts, (i) Bamboos, and (ii) Woods. It is with the former that we are here concerned. Under Bamboos he has collected information regarding the weight of green and dry bamboos, the percentage of nodes to internodes, the size of the various species of bamboos, their market value in different places and the cost of extraction from various localities to a possible factory site. He also carried out tests by the soda process on a laboratory scale, and further tests for bleaching. He ends this report by proposing possible factory sites and discusses freights and cost of chemicals. His report is of great value and the present enquiry has been based on his suggestions as to the lines on which future investigation on this subject should be carried out. In 1909, he prepared a second note on the same subject, entitled "Bamboo for Paper-making," and this report is printed on paper made from bamboo pulp.

G. F. Richmond's Report of 1906.—A series of pamphlets have been issued by Mr. George F. Richmond of the Bureau of Science, Manila, on the subject of paper-making. The first is entitled "Philippine Fibres and Fibrous Substances: their suitability for Paper-making" Vol. I, No. 5 of June 1st, 1906. The next is Part II, of the same publication,

Vol. I, No. 10, December 1906, which treats chiefly with bamboos, and Part III (conclusion), Vol. II, No. 2, Section A, May 1907.

W. Raitt's Report of 1909.—The latest articles which are to hand on this subject appeared in "Tropical Agriculture" in 1909, under the signature of Mr. W. Raitt, a pulp expert, in which he discusses the sulphite process, as compared with the soda process, in manufacturing pulp from bamboos. In another pamphlet by the same author, in the "Paper Trade Review" of 1907, is given very useful information collected by him from sample plots taken in bamboo forests, from which figures of yield are calculated. Also interesting are the experiments made by him at the Bengal Paper Mills, Ltd., which go to confirm Mr. Sindall's tests carried out by the soda process, when that gentleman was in Burma. Raitt went further than Sindall and carried out tests on bamboo by the sulphite process, but the latest results obtained by Messrs. Raitt and Coventry in India and Mr. Richmond in Manila, go to prove that bamboo sulphite pulp is difficult to bleach. His further report on this subject entitled "Report on the Investigation of Bamboo as Material for Production of Paper-pulp" is the outcome of his experiments carried out at the Forest Research Institute, in which he describes the treatment of bamboos by the Soda and Sulphate processes. He also deals with the subject of treating the nodes together with the internodes, and the treatment of bamboos before boiling. This enquiry has been made conjointly with this report and is worthy of very careful perusal.

1908 and 1909.—In 1908, there appeared three Government publications on the subject of paper-making in India. One was by Mr. R. T. F. Kirk, I.C.S., entitled "A Monograph on Paper-Making in the Bombay Presidency" which deals chiefly with hand-made paper. Another is by Mr. D. N. Mookerji, M.A., on "Paper and Papier-Maché in Bengal" and a third bearing the same title, but dealing with the Punjab, by Mr. H. W. Emerson. In 1909, a fourth monograph also bearing the same title as the above publications, was published by Mr. J. N. Gupta, I.C.S., which deals with paper-making in Eastern Bengal and Assam. Not one of these four publications throws any light on the manufacture of paper from bamboos: they deal chiefly with hand-made paper.

There is a large amount of miscellaneous literature available on this subject, often of a very instructive nature, which has appeared in various Indian newspapers and periodicals, none of which, however, deals so intimately with the subject of bamboos as do the various reports and

articles published from time to time by Messrs. Sindall, Raitt and Richmond.

2. Present condition of the paper-pulp trade in India.

Materials used for paper-making in India.—At the present day paper is made of either waste materials such as rags, old rope, gunny bags, waste paper, etc., or from raw material such as grass, reeds, straw, wood, etc. By far the greater portion is, however, manufactured from either rags, waste paper, grass or wood. In India the chief raw material used is a grass, known as Sabai or Baber (*Ischæmum angustifolium*), which is obtained from the forests of Bengal, Orissa, Nepal and the United Provinces. No chemical or mechanical wood-pulp is made in this country though considerable quantities are imported by the existing paper-mills. The other materials used in India for the manufacture of paper are rags of poor quality, hemp, jute, gunny bags, waste paper and old rope.

Present position of affairs.—Much has appeared of recent years in periodicals and newspapers in India on the subject of the world's supply of paper. Without doubt the demand is extremely large, the present outturn according to Raitt being about 8 million tons, of which about half is produced in Europe and the remainder in America. The quantity of raw and waste material necessary to produce this amount of paper must be enormous. It is said that at least 6½ million tons of paper are produced from spruce and pines in Northern Europe, America and Canada. It is, therefore, on timber that the world at present relies for its principal supply of paper, and the question naturally arises whether the supply of timber is sufficient to meet the ever-increasing demand. The answer is without doubt in the negative. The supplies from Norway, Sweden, Denmark and Russia are not yet exhausted but already many warning notes have been sounded in that direction. The time must therefore come when the supply will run short, for in spite of strict protective measures which have been taken to ensure the preservation of the forests, the annual outturn is now in considerable excess of the possible sustained yield. Similarly, the United States have taken warning and their Government recently appointed a Commission to enquire into the subject of the supply of raw material for paper. Their report points out that matters have already gone far and proposes measures of economy. Canada still contains a vast amount of timber, but experience has

shown that no forests are really inexhaustible. History is therefore repeating itself in the matter of the supplies of the raw materials for the manufacture of paper. The first instance was when the amount of rag available was insufficient and Esparto grass came in during the fifties to save the situation. A similar difficulty arose in the seventies and this time the situation was saved by the introduction of spruce wood-pulp. Again in 1910 the position became acute. It is true that the prices of chemical wood-pulp have not as yet shown any startling upward tendency, but the continuous fall in prices of both wood-pulp and the paper made from it, came to a sudden stop five years ago, while the absence of any serious rise in prices is due to the stress of competition in the producing countries. It is believed in paper-making circles that these conditions cannot continue, and that prices must inevitably rise in the near future as the ever-increasing shortage of wood makes itself more seriously felt.

Mr. A. D. Little, Chief Scientific Officer to the American Paper and Pulp Association, in a report on this subject, emphasises "the growing scarcity of pulp wood, the continually rising price and longer haul with which paper-makers using this material are now contending, and the coming competition of new and better stocks which even now can be produced more cheaply than any bleached wood fibre."

"Wood, as a raw material, has proved so available, convenient, compact, easily handled, and heretofore so cheap, that we have been led to overlook or ignore the immense sources of other and better paper stocks which lie easily within our reach.

"We are not dealing with the perennial suggestions of visionaries who see a paper stock in every thing which has a fibre, but are instead, concerned with the serious proposals of capable technologists whose conclusions are based on careful study."

History of paper-mills in India.—The first paper-mill in India was erected at Serampore and is reported not to have been a success. The next venture was that made by the Bally Paper Mills Company in 1874; for ten years it flourished; after that it did not pay and finally went into liquidation in 1906.

At present there are six or seven paper-mills in India. The largest is the Titaghur Paper Mills Co., Ltd., with two mills near Calcutta, the older mill being situated at Titaghur and the newer mill at Kanknarrah. Their present outturn is about 14,000 to 15,000 tons of

paper per annum, made of Sabai grass, imported spruce wood-pulp and a limited amount of jute, hemp and rags.

The next most important paper-mill is situated at Raneegunge on the East Indian Railway, some 120 miles from Calcutta which belongs to the Bengal Paper Mill Co., Ltd. Their paper is made of the same materials as at Titaghur and the outturn is about 6,700 tons per annum.

Another large paper-mill exists at Lucknow, known as the Upper India Couper Paper Mills, Ltd. The raw material used in this mill is also grass, but old rags, waste paper, jute, gunny bags, and hemp here play a larger part in the manufacture of paper than is the case in the other mills.

The fourth mill of any size in India, is in the Western Presidency, at Poona, and is known as the Deccan Paper Mill Co., Ltd. The materials used in this mill are the same as elsewhere in India, though Sabai grass does not appear to play so prominent a part as in Bengal mills. The outturn is stated to be 1,000 tons of paper per annum.

A few smaller mills exist in India and a certain amount of hand-made paper is manufactured, but the total outturn of this grade of paper is not sufficient to seriously affect the market.

Imports and exports of paper in India.—The exports of Indian made paper and paste boards are at present practically *nil*. It is not impossible, however, that this state of affairs may one day be changed, when it is considered that enormous quantities of raw material suitable for the manufacture of paper, but not as yet utilized, are available in the forests of India and Burma. At present we are only concerned with the imports of paper and the outturn of the existing Indian paper mills; the question of exporting half-stuff or paper from India may come later, but the question of supplying the existing market is the one which is at present attracting the attention of the Indian paper-makers.

The value of the imports during the last five years was as follows :—

Class of paper imported.	1905-06.	1906-07.	1907-08.	1908-09.	1909-10.
	Rs.	Rs.	Rs.	Rs.	Rs.
Printing paper . . .	21,32,459	28,33,632	36,26,984	30,96,000	33,18,292
Writing paper and Envelopes	19,15,114	22,66,714	28,09,522	23,83,354	25,53,561
Other kinds of paper . .	26,49,757	25,75,366	31,42,264	33,39,036	37,43,901
Paste, Mill and Card boards of all kinds.	3,51,648	3,35,393	3,45,492	4,45,005	5,14,495
TOTAL . .	70,48,978	80,11,105	99,24,262	92,63,396	1,01,30,249

From the above figures it will be seen that the imports have increased to the value of 31 lacs of rupees in the last five years. The most steady increase comes under "Other kinds of paper," namely, the paper which finds its way into the bazar, and it is against this imported paper that it is hoped that the Indian paper-mills will be able to compete with the help of bamboos as a raw material.

To arrive at a definite conclusion as to the relative position of affairs it is necessary to compare the present outturn from Indian mills with the amount imported into this country. The figures for the last five years are as under :—

Year.	Produced in India.	Imported.
	Rs.	Rs.
1905-06	51,86,729	70,48,978
1906-07	63,10,940	80,11,105
1907-08	72,90,385	99,24,262
1908-09	75,87,267	92,63,396
1909-10	79,11,943	1,01,30,249

It will be seen from the above statement that though the amount produced in India shows a steady increase amounting to 27 lacs of rupees in five years, the imports show an increase of 31 lacs during the same period. Again the Indian made paper amounts to 44 per cent. of the total consumption against 56 per cent. of imported paper, so that there is ample room for the further development of the Indian product, provided it can be put on the market at a somewhat lower rate than at present. There is yet another factor in favour of the Indian paper-maker. Merchants purchasing imported paper have to take up large consignments at one time and pay on delivery. This is often an inconvenience to traders, who naturally object to investing large sums of money in a commodity which does not improve by keeping and which they cannot dispose of quickly, so that when paper can be purchased for retail purposes in smaller quantities, as is possible from Indian mills, they can afford to pay up to 10 per cent. higher prices for the same article

than it is possible for them to do for large quantities of the imported material.

Cost of paper in India.—The number of grades of paper found on the Indian market is very large and market values vary considerably. The following may be taken to be the present average wholesale rates in the Calcutta market of the grades most likely to be affected by the introduction of a better supply of raw material :—

Writing paper	Rs. 400 per ton.
Superior printing paper	Rs. 330 „ „
Common „ „	Rs. 290 „ „
Half bleached paper	Rs. 280 „ „

From the published financial results of the companies concerned during recent years, it is clear that these prices carry a margin of profit so small that a very slight adverse disturbance of the prevailing conditions would wipe it out altogether. In the opinion of Mr. Raitt, who knows the mills well, this unfortunate state of affairs is not in the least due to deficiencies in the equipment of the mills or in their organisation and management, but solely to the lack of an adequate supply of cheap raw material.

State of Indian paper market.—To compete with the low prices of imported bazar paper it is necessary to produce a pulp at cheaper rates than can now be done with Sabai grass, mixed with a certain amount of imported wood-pulp, so that some other raw material must be found as a substitute, and from the trials recently carried out on a commercial scale it is believed that bamboos will answer the purpose.

There is another factor to be considered in connection with the price of the better classes of paper as supplied to Government and large firms by the Indian paper-mills, and that is that the cost at which Sabai grass paper can be supplied, is now so high that it is nearly possible to import equally good paper made of Spruce pulp treated by the sulphite process. In other words, the Indian high class papers are in danger of being undersold by equal grades of imported spruce paper. It is understood that this has already occurred in Madras, and that that Government have given up their Indian contracts and taken to European-made paper. This is an extremely serious state of affairs for the Indian paper-makers.

The Indian paper-maker has therefore two interests at stake, one is to keep down the cost of manufacturing his better grades of paper so as not

to lose his present market for that commodity, and the other is to reduce the cost of production of his cheaper grade papers so as to enable him to compete successfully against the imported "News" and Bazar paper. It is hoped that it will be possible to do this with the help of bamboo-pulp.

3. General conditions necessary for the successful establishment of a paper-pulp mill.

The conditions necessary for the successful establishment of a paper-pulp mill are manifold, and can only be found in a few localities. Even in the most favourable localities some factors of minor importance, though none the less necessary, are often absent, so that the best that can be done is to choose a locality where the most important conditions to ensure success are to be found.

Conditions necessary for the establishment of a mill.—The most important conditions necessary may be summarised as follows :—

(1) That a sustained annual yield of a suitable raw material for the manufacture of pulp be available in abundance.

(2) That the cost of extraction of the same can be kept within economic limits for many years to come. For bamboos the maximum price is put at Rs. 15 per ton of dry internodes landed at the mill, but it should, generally speaking, be less. By treating the nodes also, the price can be reduced by 7 to 15 per cent., according to species, as that amount of waste will be saved by utilizing the nodes.

(3) That the raw material should have little or no local value or should be available in such quantities that the requirements of a mill do not interfere with the local demand and prices.

(4) That the crop from which the raw material is drawn be a close grown one, in other words, gregarious, so that the cost of collection, and the area over which supervision is necessary, be reduced to a minimum.

(5) That the factory site selected be such that the raw material can be floated down stream to the mill door. Further it is necessary that there be direct communication by river between the mill and sea-port in order to import the necessary chemicals and coal and export the manufactured pulp. It is

preferable that the lead from the forest to the mill and from the mill to the sea-port be as short as possible though the latter is the more important factor of the two.

(6) That lime be available at cheap rates and in large quantities.

(7) That a plentiful supply of fresh water be available.

(8) That labour in sufficient quantities be forthcoming to carry out the work of extraction and to run the mill.

(9) That the locality be reasonably healthy.

(10) That the river be not subjected to excessive floods.

In the above list of conditions nothing has been said about the sale of the manufactured produce, as it stands to reason that, provided a fair quality of pulp can be put on the market at a sea-port at a reasonable cost of production, the only limit to its sale is the economic distance to which it can be exported. As an illustration of the above, the following case may be quoted. Supposing it is possible to land a certain grade of bamboo-pulp in Rangoon at £6 per ton, it might pay to export it to Calcutta or Madras, but not to Europe, or again it might be possible to export it to Japan, in competition with European pulps now imported into that country.

From what has been said above, it will be understood that the number of localities in India and Burma which fully meet all these conditions must necessarily be limited. It is thought that certain places in Lower Burma do so, such as areas on the eastern and western slopes of the Pegu Yomas, which drain into the Sittang and Rangoon or Myitkara rivers, respectively. Again certain localities in Arakan and possibly along the Chittagong and Orissa coasts are suitable, and lastly the Malabar Coast, with its many perennial streams running down to the sea from the teak and bamboo forests of the Western Ghats.

The separate cases which have been drawn up for these various localities in India and Burma are given in Part IV of this report, and are the result of careful inspections and enquiries made on the spot and based on the necessary conditions enumerated in the foregoing paragraphs.